THE ZOO GOER

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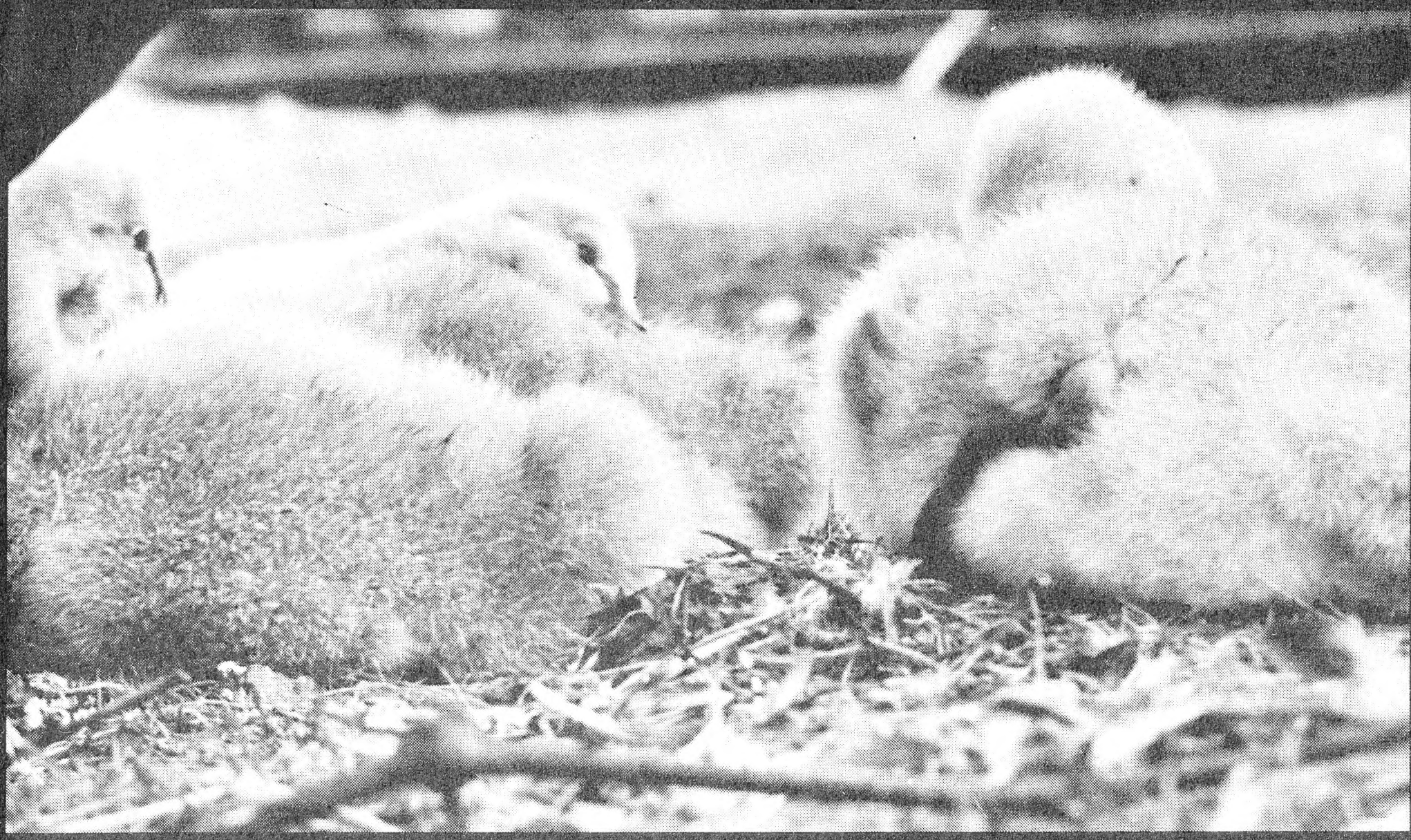


Black Swan Cygnets

On February 19th, three black swans *(Cygnus atratus)* were hatched in one of the National Zoo's lower waterfowl enclosures *(number 30d on map)*. The cygnets — as the hatchlings of swans are called — had light brownish gray downy plumage and black bills in contrast to the black plumage and red bills of the adults. Exhausted by the effort of hatching, the cygnets spent the first day of their lives asleep beneath their mother's wings. At first each cygnet's downy feathers were encased in waxy sheaths which protected them from the liquid inside the egg, but these gradually rubbed off through contact with the mother's wings and body. By the next morning, the three young birds — "ugly ducklings" by no means — could be seen swimming with their parents and an old female (their maternal grandmother) or following the adult birds on land.

Over a month earlier, the adult swans had built a large nest of sticks, and the female had lined it with nest down which she pulled from the underside of her own body. This down — which is white in all swans, even the black swan — appears under the contour feathers on the underparts of a female in breeding condition. Both parents shared in incubating the pale green eggs. In this species the female — or pen, as she is known in the terminology of the old English swan-masters — usually is charged with the task of incubation at night, while the male, or cob, takes over for her during the day.

When one of the birds relieves its mate, there is an elaborate changing-of-the-guard ceremony. The relieving swan approaches the nest, holding its head high, raising its wings, fluffing out its neck feathers, and giving a special two-syllable greeting call; the bird on the nest replies with the same call. The new arrival climbs on the back of the nest and remains there for a minute or two, continuing to call and bow its head. Then the bird on the nest stands up, allowing the other to slide under its tail onto the eggs. When leaving the nest, the bird that has been relieved picks up two or three beakfuls of nesting material and passes them back to its mate.

Two days before the eggs are ready to hatch, the first sound is heard from them; this is a repeated soft clicking, produced by the cygnet's breathing. Later the cygnet makes its first, high-pitched vocalizations, to which the mother replies by calling softly. The hatchling has a so-called egg-tooth on the tip of the upper mandible of its bill which it uses to break through the eggshell; the egg-tooth falls off shortly after the bird has hatched. The hatchling makes a first opening near the end of the egg, then rests for several hours. Next, rotating inside the egg, it makes a complete circle of similar holes all around the egg. Finally it stretches its neck and legs energetically to push off the perforated end of the egg with its head.

As shown in classic studies by Konrad Lorenz and others, newly hatched waterfowl will accept as their parent the first large moving object they see. This phenomenon is known as imprinting. Cygnets, ducklings, and goslings hatched in incubators may become imprinted on their human caretakers and follow them as they would follow their parents. In the wild, however, because the young waterfowl is able to swim and walk so early in life, a strong instinct to follow its parents is very important for its survival.

If it does become temporarily lost, the black swan cygnet has a shrill distress call, which induces one or both of its parents to indicate their location by calling back or perhaps to come and recover the lost cygnet. The young bird may use this same distress call to indicate that it is cold or hungry. Another call — a gentle trill — is used to indicate that the cygnet is sleepy. Members of the brood also give these calls as they nestle together to sleep, their eyes half closed and their bills often buried in each other's down. On these occasions,

their calls induce the mother to brood her young or cover them with her wing as they sleep and probably also encourage all of the cygnets to go to sleep at the same time.

The black swan is native to Australia, where it inhabits lakes, marshes, bays, and coastal lagoons. About one hundred years ago it was introduced to New Zealand, and now it is widespread there. Its highest concentrations are found on the southeast corner of Australia and on Tasmania. It is common along both the western and eastern coasts of the continent and well inland from them; in addition, occasional wanderers have been found in suitable habitats throughout the continent. The erratic Australian rainfall often produces temporary wetland, of which the swans soon take advantage, sometimes remaining to breed. The Dutch navigator Willem de Vlaming first discovered this species on an estuary in Western Australia later called Swan River; and specimens he brought back to Europe excited great curiosity and incredulity, since a "black swan" had long been proverbial for an impossible occurence.

Black swans are highly gregarious, often assembling in large numbers; in 1957 for instance, 50,000 were counted on Lake Albert in South Australia. Unlike other swans they are colonial nesters. Breeding mainly takes place in December and January — late spring and early summer in the Southern Hemisphere. There is a great deal of variation, however; in some years black swans in the wild breed all year round — as the National Zoo's black swans do — and in some years very few of the species nest at all. It has been suggested that the timing of the breeding season in the wild is related to the availability in luxuriant quantities of the marsh plants and algae on which the swans and their young feed.

At their vast breeding assemblages in the wild, black swan pairs engage in a distinctive courtship ritual; this same behavior can be seen when the Zoo's black swans are mating. First both birds repeatedly dip their heads beneath the water, gradually synchronizing their movements, and they pause occasionally to hold their heads upright with their necks close together. Meanwhile the wings are held low, often dragging in the water. Eventually the cob mounts, taking hold of the pen's neck feathers with his bill. After mating, both swans rise half out of the water, their necks extending straight up, and nod their heads repeatedly. Then they swim together in a circle, bathe and preen, and wag their tails vigorously.

In the wild black swan cygnets normally stay with their parents until they are six months old. By this time they have increased in weight to about seven pounds — over 25 times their weight on hatching. Meanwhile their gray downy plumage has been replaced by their first coat of black contour feathers. At the age of about 55 days — when the cygnet weighs some two pounds — the feathers have appeared on the shoulders and wings; tail feathers may have started to grow slightly earlier but are not readily visible. The Zoo's current black swan cygnets will reach this stage in late April. Next to appear are the feathers on the belly, flanks, and head and then the flight feathers on the wing. Before these feathers appear in the Zoo's cygnets, the birds will already have been pinioned. In other words, as is the practice with all captive waterfowl kept in open ponds, the part of the wing on which the primaries, the major flight feathers, are located will have been removed on one wing, rendering the bird's wing surface asymmetrical and thus useless for flight. Down remains longest on the back and underside of young black swans; all other areas but these are feathered when the cygnet is between 75 and 95 days old.

Zoo visitors will be able to see the current cygnets going through these growth stages. In addition, as black swans have done at the Zoo for many years, the pair at the lower waterfowl pond will probably mate and nest again this spring, possibly laying a new clutch of eggs as soon as early May.

ZOONEWS
Mammals

Red Kangaroo Joey

On February 25th, a movement was noticed in the pouch of the younger of the Zoo's two red kangaroo females *(number 9i on map)*, indicating that she had a joey. It was impossible to say exactly when the joey had been born; but it would probably be several months before the infant was regularly visible. However, since the young of this species remain in the pouch some 235 days, emerging occasionally in the later months, visitors can expect to see the joey in and out of the pouch throughout the summer.

This female kangaroo is carrying an infant in her pouch *(number 9i on map)*.

Reproduction in this species of kangaroo *(Macropus rufus)* is better known than in most marsupials; dramatic films of red kangaroo births finally established the true nature of kangaroo birth, which had been the subject of learned controversy as long as these unique animals had been known to science. It had often been supposed that the infant – born in an almost embryonic state and weighing only about one thirtieth of an ounce or one thirty-thousandth of its mother's weight – was assisted into the pouch in some way by the mother. It was demonstrated, however, that the young must climb into the pouch on its own, hoisting itself through its mother's fur by means of its strong forearms. The mother assists it only in that she makes the path from the vagina to the pouch opening nearly horizontal by sitting back in a slouching posture with her tail tucked forward between her legs.

The red kangaroo is named for a bright red powder-like substance secreted from the skin of the male's chest and throat in breeding season, which he rubs on his back with his hands. This species is found on plains and in near-desert areas throughout Australia. Recent investigations have shown interesting adaptations in the red kangaroo's reproductive life for the harsh conditions under which it lives, where infant mortality is very high.

It has been discovered that in the wild 60 to 70 percent of all red kangaroo females carrying young in the pouch are pregnant with another offspring. It seems that females frequently copulate soon after giving birth, but the embryo only develops to the point where it comprises about 100 cells. It remains at this stage of development until the joey in the pouch either dies or becomes independent; then the second joey's development continues, and it is born about four weeks later.

New Bat Species

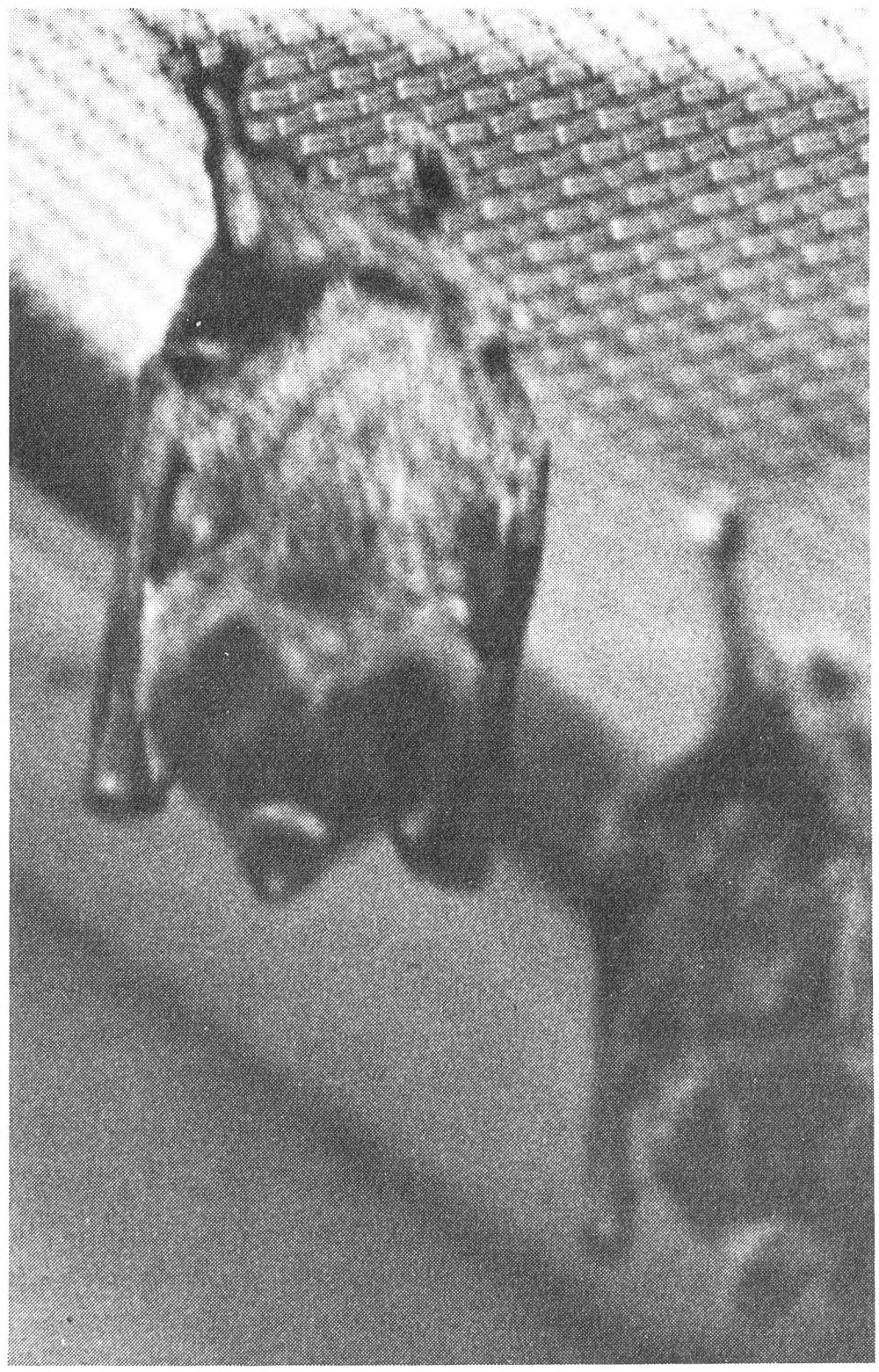
Two new species of bats have been placed on exhibit in a cage to the right of the front door of the Small Mammal House *(number 15 on map)* One, Linneaus' short-tailed bat or the common short-tailed bat *(Corollia perspicillata)*, is represented by two males and two females, while the other, the somewhat larger Geoffroy's long-nosed bat *(Anoura geoffroyi)*, is represented by one male and one female. Both species are native to Central and South America and are members of the same family, the American leaf-nosed bats *(Phyllostomidae)*, so named for the fleshy "leaf" present on the snouts of most of the species. They are quite active and can readily be seen flying around their unlighted enclosure with a swift, fluttering flight.

Bats constitute the largest order of mammals except for the rodents; there are some 2,000 species known. They are believed to have first evolved the power of flight about 60 million years ago in order to pursue winged insect prey, and a majority of species are still insectivorous. However, throughout the history of the order, various species have adapted to various other diets. The common short-tailed bat is an example of a fruit-eating species as are the large grey-headed fruit bats *(Pteropus poliocephalus)* located in the nocturnal room at the Small Mammal House. Geoffroy's long-nosed bat also feeds to a certain extent on the pulp of fruit; but it derives the bulk of its nourishment from a still more unusual diet — the nectar of flowers.

The common short-tailed bat is one of the most abundant bats from Central Mexico to Peru and southern Brazil. It feeds on a variety of fruits, including ripe bananas, plantains, mangoes, guavas, and wild figs, and it is important for disseminating the seeds of a number of fruit-bearing plants. At the Small Mammal House, they appear to thrive on the bananas hung at various locations around their cage. Members of this species evidently have a well-developed sense of smell, which they use to locate their food in the wild; they are said to forage twice a night, returning each time to special roosting sites to eat and digest any fruit they have found.

These bats spend their days in tunnels, mines, caves, hollow trees, and buildings, often in colonies numbering in the thousands. Other species, including Geoffroy's long-nosed bat, may share the roosting site. The common short-tailed bat is known for its rapid straight flight in open areas, but it is also able to maneuver with considerable agility when flying in between the branches of trees in forests. As most other bats apparently do, it navigates by means of echo-location; in other words, it is able to locate obstacles in its path by emitting high-pitched vocal signals — inaudible to humans — and gauging the distance of objects from which they are reflected.

Geoffroy's long-nosed bat shows remarkable adaptations for its unusual diet. Its tongue has bristles for lapping up nectar; and when extended to its full length — as it is when the bat reaches with it into the corolla of a flower — it is longer than the bat's head and body together. It is believed that these bats play a valuable role in cross-pollinating some of the night-blooming plants on the nectar of which they feed, in a manner analogous to the way in which bees and other insects cross-pollinate other flowering plants. Evidently pollen rubbed off on the bat's head and shoulders as it feeds from a flower is frequently carried by the bat to another flower of the same species.



Paca Born

A pair of pacas *(Cuniculus paca)* in a cage at the rear of the Small Mammal House *(number 15 on map)*gave birth to a single young in early February. The infant of these large rodents was first spotted by keepers on February 5th, when it was about three days old. It was very precocious and already moving around quite freely at that time; a day later it was seen eating solid food. By the time it was a month old, it was always the first to emerge from the pacas' nest box at feeding time.

The young paca's precocious development is rather unusual for a rodent. Mice and rats *(family Muridae)*, for instance, give birth to 10 to 15 blind and hairless young in a litter, while the paca gives birth to one or occasionally two well-developed offspring. However, the young paca has a protracted adolescence and stays with his mother up to five or six months, much longer than most young rats or mice do.

These Central and South American rodents, which as adults may weigh over 20 pounds, are nocturnal forest-dwellers. They spend the day in burrows which they dig themselves in banks, among tree roots, or under rocks. The burrow usually has several escape exits. Pacas prefer areas where water is available nearby; they are excellent swimmers, and readily take to water to escape from predators.

The young paca born in February at the Small Mammal House *(number 15 on map).*

Sugar Glider Births

Two of the females in the sugar glider group on exhibit in the nocturnal room at the Small Mammal House *(number 15 on map)* have given birth to single young. Like other marsupials, sugar gliders give birth to their young in an extremely undeveloped condition and nurse them in a pouch; thus the young were not noticed until February 24th, when they were both in the pouch and were both estimated to be between a month and two months old.

The sugar glider *(Petaurus breviceps)* is a classic example of what is known as parallel evolution. It has evolved parachute-like membranes between its front and hind limbs and gliding habits that closely parallel those of the "flying squirrels"; flying squirrels, however, are rodents, not marsupials, and are thus not closely related to the sugar glider. Sugar gliders have been reported to glide from tree to tree for distances up to 50 yards. Like our familiar North American flying squirrels, they are strictly nocturnal; and another characteristic of the sugar glider that parallels the flying squirrel is its large eyes, adapted for improved night vision.

During the day, sugar gliders sleep in nests in hollow trees. For this reason, although they are among the most common of Australian mammals, they are not often seen. They line their nests with leaves, which they usually collect by hanging from their hind feet, picking the leaves with their forefeet, and in turn passing them to the tail, which coils around them and holds them while the sugar glider returns to its nest. While the animal is gliding, the tail functions as a rudder, so when carrying nesting materials the sugar glider cannot glide but must climb back along the branches.

The name "sugar glider" derives from the fact that in captivity members of this species have proved to be very fond of sugar. In the wild, their "sweet tooth" is satisfied by feeding on blossoms. In addition, they eat insects and fruits.

Like all marsupials, the sugar glider has a very short gestation period; it is only three weeks between conception and birth in this species. The young are fully independent of the mother by the time they are about four months old, but they may remain in their parents' nest for several years. Groups made up of parents and their offspring of previous years may number up to a dozen, all sharing one nest with the same tolerance for one another's close proximity that can be seen in the Zoo's sugar glider group.

Renovations Scheduled

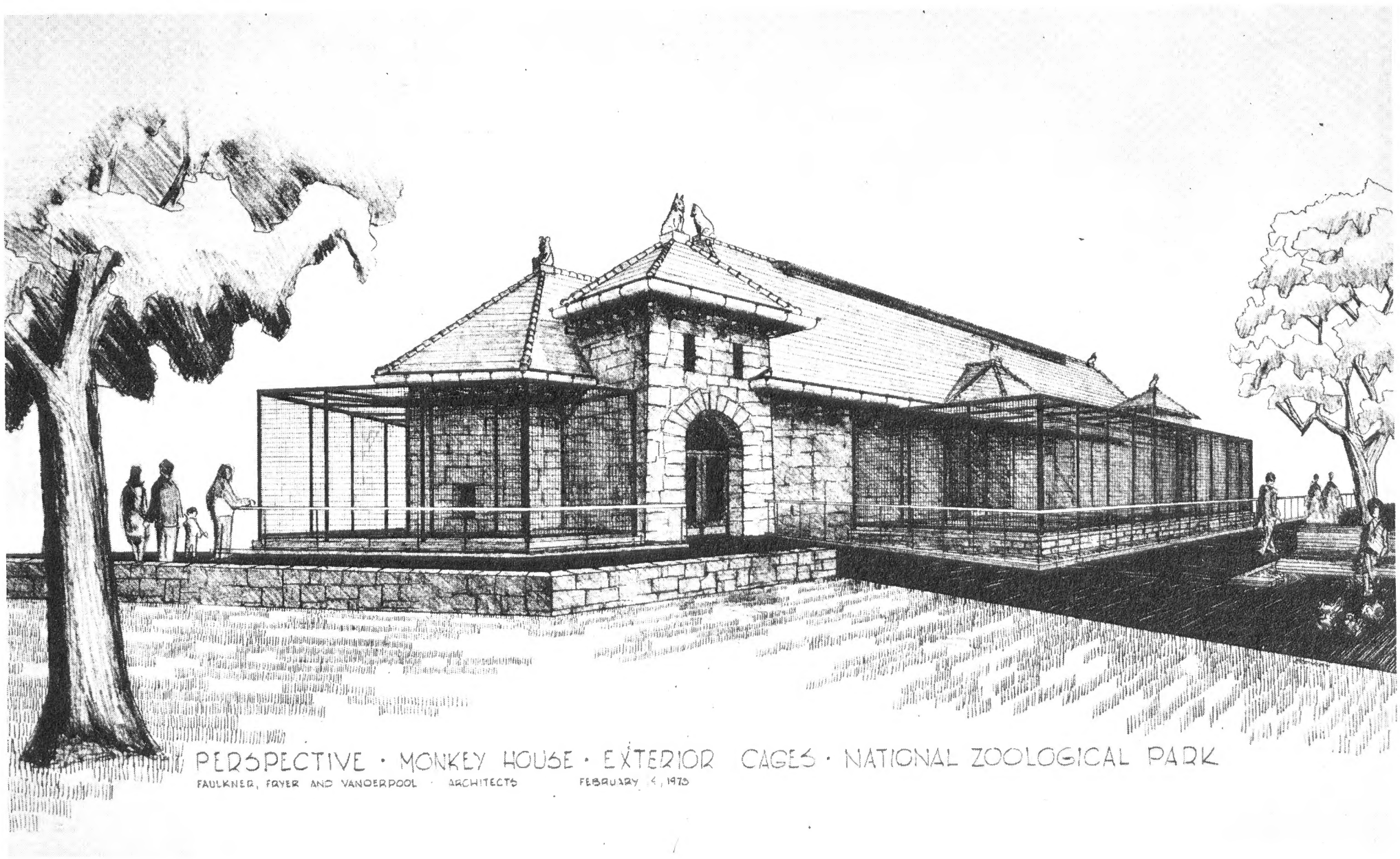
The planned renovation of the National Zoological Park is scheduled to begin this fall. At that time two of the Zoo's older buildings, the Monkey House *(number 21 on map)* and the Puma House or Lesser Cat Building *(number 29 on map)*, will be closed for complete remodelling. The animals in these buildings will either be kept in other parts of the Zoo or sent to other zoos, either on loan or permanently.

Several months later, the Lion House *(number 23 on map)* will be closed. This building will be replaced by spacious grottos covering the entire current Lion House hill, to be occupied by all of the greater cats. Before the building's closing, however, the complex process of relocating all of its inhabitants will begin. The sloths and tree kangaroos will find temporary homes in the Reptile House *(number 19 on map)*. Other animals will be sent to other zoos, some temporarily, some permanently. The Zoo's famous white tigers will be loaned to Chicago's Brookfield Zoo, the home of the male tiger currently on loan to the National Zoo. This male has incidentally bred with both the normally colored female Kesari and the white female Mohini.

The construction in the Lion House area will also necessitate the evacuation of the enclosures behind the building *(numbers 22a-o on map)*. One of the results will be that the young pair of tapirs now located there *(number 22e on map)* will have to be moved to the Zoo's other tapir enclosure *(number 26e on map)*. The older pair that formerly occupied this enclosure have been sent – along with their recent offspring – to the Salisbury, Maryland, Zoo.

Other current construction includes the preparation of enlarged outdoor yards for the giant pandas *(numbers 10 a-b on map)*; work is scheduled to be completed by labor day. Each of the new yards will cover a quarter of an acre – four or five times the size of the pandas' present yards – and will be planted with willow trees and bamboo. A moongate will connect the two enclosures. It will be covered with wire mesh through which the pandas will be able to see each other, and it will be opened for mating when the pair are sexually mature in 1975 or 1976.

Rendering—Drawing by architects Faulkner, Fryer, and Vanderpool of the new Monkey House; there will be larger cages and a smaller number of species on exhibit.



Birds

Coscoroba swans, located on the waterfowl pond behind the Bird House *(number 5 on map).*

Coscoroba Swans

One of the most interesting of recent waterfowl acquisitions is a pair of Coscoroba swans *(Coscoroba coscoroba),* currently on exhibit in an enclosure behind the Bird House *(number 5 on map).* These handsome white birds with pink bills and legs may at first sight appear to resemble very large geese rather than swans. Their necks are proportionately shorter than those of typical swans *(*genus *Cygnus)*; and their legs are not set so far back on the body as in familiar swan species, resulting in far less awkwardness on land. Indeed, many authorities question whether *Coscoroba coscoroba* should properly be called a swan at all; as can be seen from a comparison of its broad, flattened bill with a goose's narrow bill, however, the differences between it and true geese *(Anser* and *Branta)* are even greater. It is currently considered to be intermediate between the true swans and a group of rather primitive waterfowl known as the whistling ducks or tree ducks (genus *Dendrocygna*).

Coscoroba swans are found in the southern third of South America from northern Chile and southern Brazil through Tierra del Fuego. They are believed to feed mainly on water weeds, seeds, and some aquatic invertebrates. They usually build their nests in shallow water, piling up a small island of reeds and mud and lining a hollow in its center with grass and down. The young do not resemble those of true swans; for, rather than being wholly gray, they have a band of pure white across the back of the head and black markings on the top of the head, on the face, and on the back. Among other recent acquisitions *(number 30d on map)* are a male and two females of another are a male and two females of another interesting waterfowl species, the falcated duck *(Anas falcata).* These relatives of the mallard breed in eastern Siberia and winter in China, Korea, and Japan. The species is distinguished by the long, curving nuptial plumes that adorn the drake's shoulders. These silvery feathers appear only in the spring and summer breeding season; the Zoo's male is wearing them at this writing.

A hoopoe in the indoor flight room at the Bird House *(number 5 on map).*

Hoopoes Nest

Spring was heralded by increased activity among many of the avian species in the Indoor Flight Room at the Bird House *(number 5 on map).* Among the most noticeable were the six hoopoes *(Upupa epops)* in the room. Males of this species fought with each other, sometimes taking hold of each other's bills in mid-air, and, chattering noisily, repeatedly pursued other males and females around the room. At least three males divided up the room, each choosing a perch from which he gave the unforgettable "hoop-hoop" call for which this species is named. On one occasion a male was seen courtship-feeding a female, flying up to her to present her with a large cricket he had found.

Finally at least one pair began to nest and laid two eggs in one of the nest-boxes set in the artificial cliffs of the room. Often the male could be seen flying up to the nest entrance to feed his mate, who spent most of her time inside the nest incubating the eggs. When the young hatched in late March, they were fed by both parents. They would not emerge from the nest until a month old, when they would be little different from the adults in plumage but with much shorter bills.

Boat-Billed Heron Chicks

On March 8, three boat-billed herons *(Cochlearis cochlearis)* were hatched in a large, disorderly stick nest in the spacious marsh bird cage at the rear of the Bird House *(number 5 on map).* The young herons had gray down on their bodies and black heads. Their bills were short and relatively narrow, in contrast to the remarkably developed bills of the adults.

No one knows for certain what type of diet the boat-billed heron has evolved its unique bill to feed on. This species is nocturnal in the wild and inhabits dense mangrove swamps from southern Mexico south through Brazil, where it is seldom seen. Some have reported that it feeds on a typical heron diet of worms, crustaceans, amphibians, and fish; but others have doubted whether its unwieldy bill could be used to capture such active prey as frogs and fish and have expressed the opinion that it must be used to strain through mud for slower-moving lower animals. One use of the bill is known; in courtship, both males and females clatter their bills and erect their long black crests.

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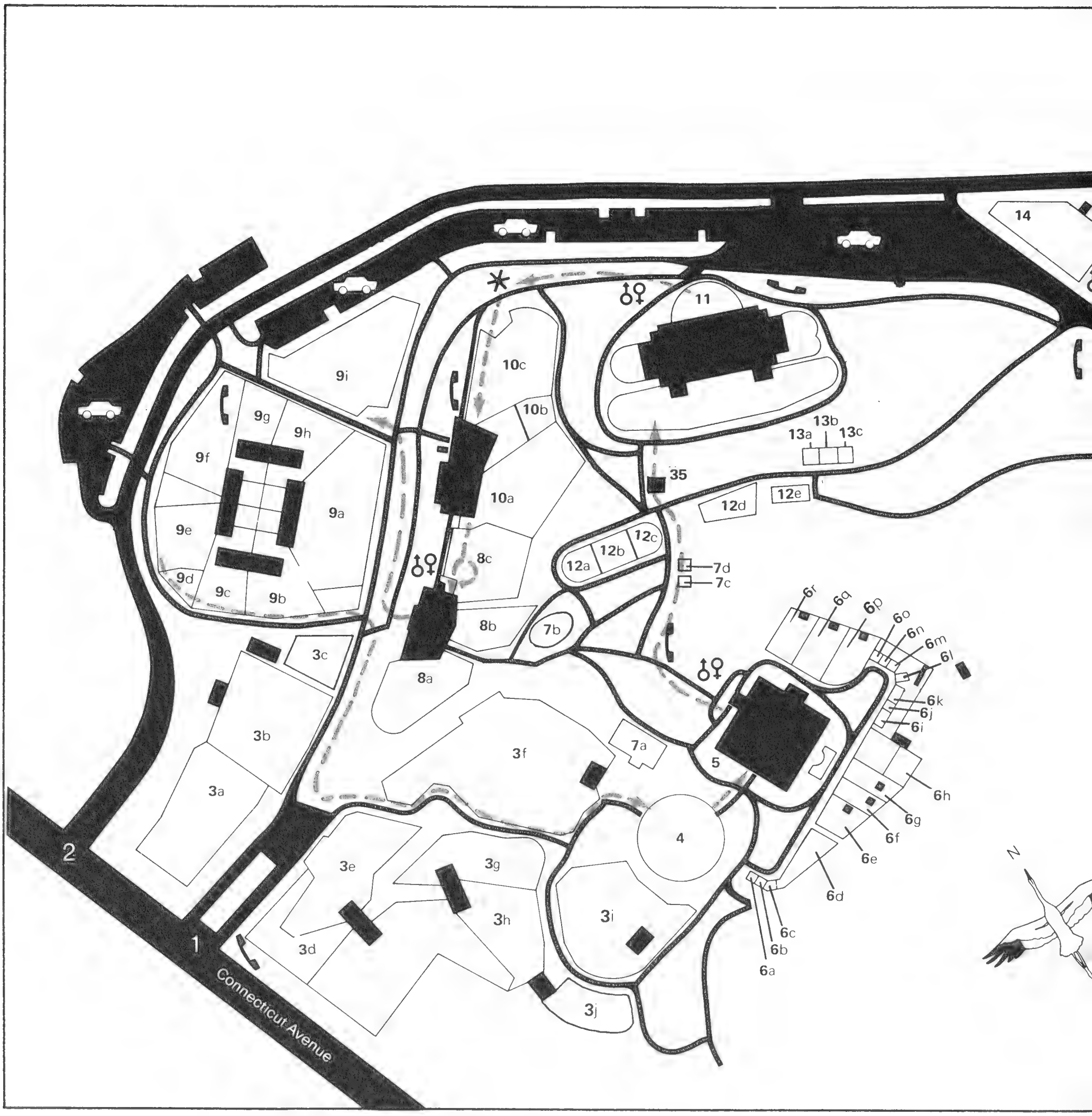

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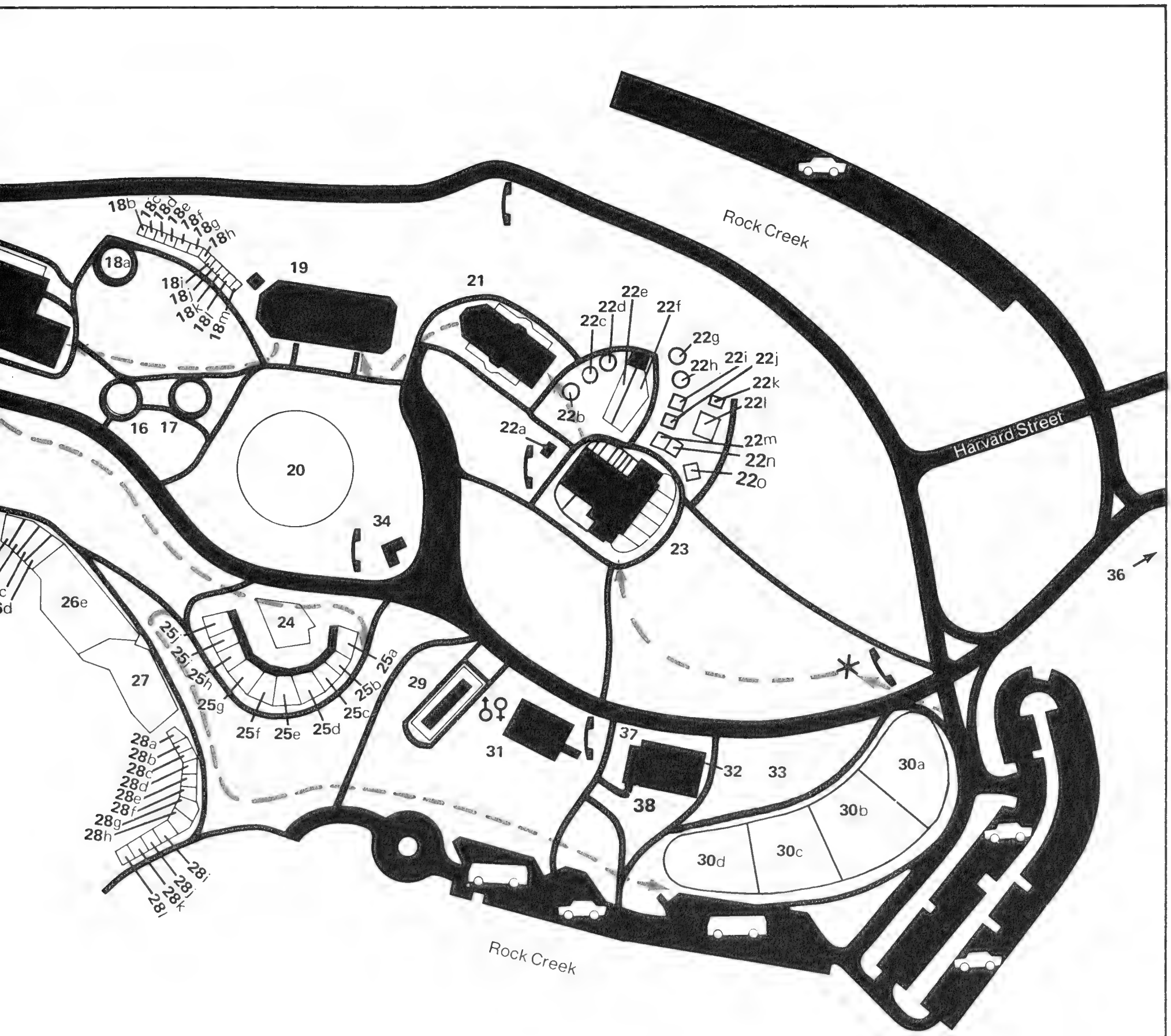

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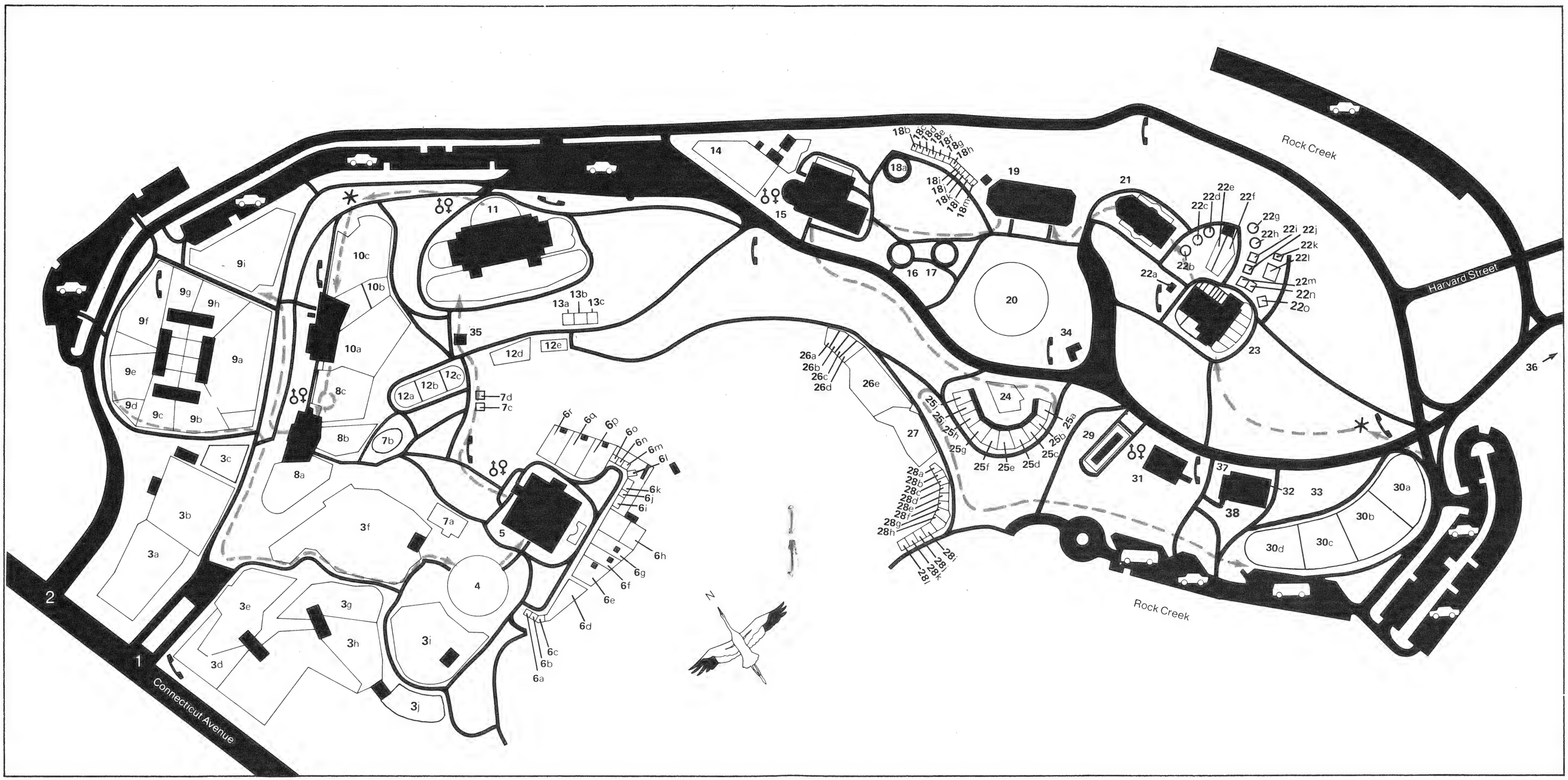
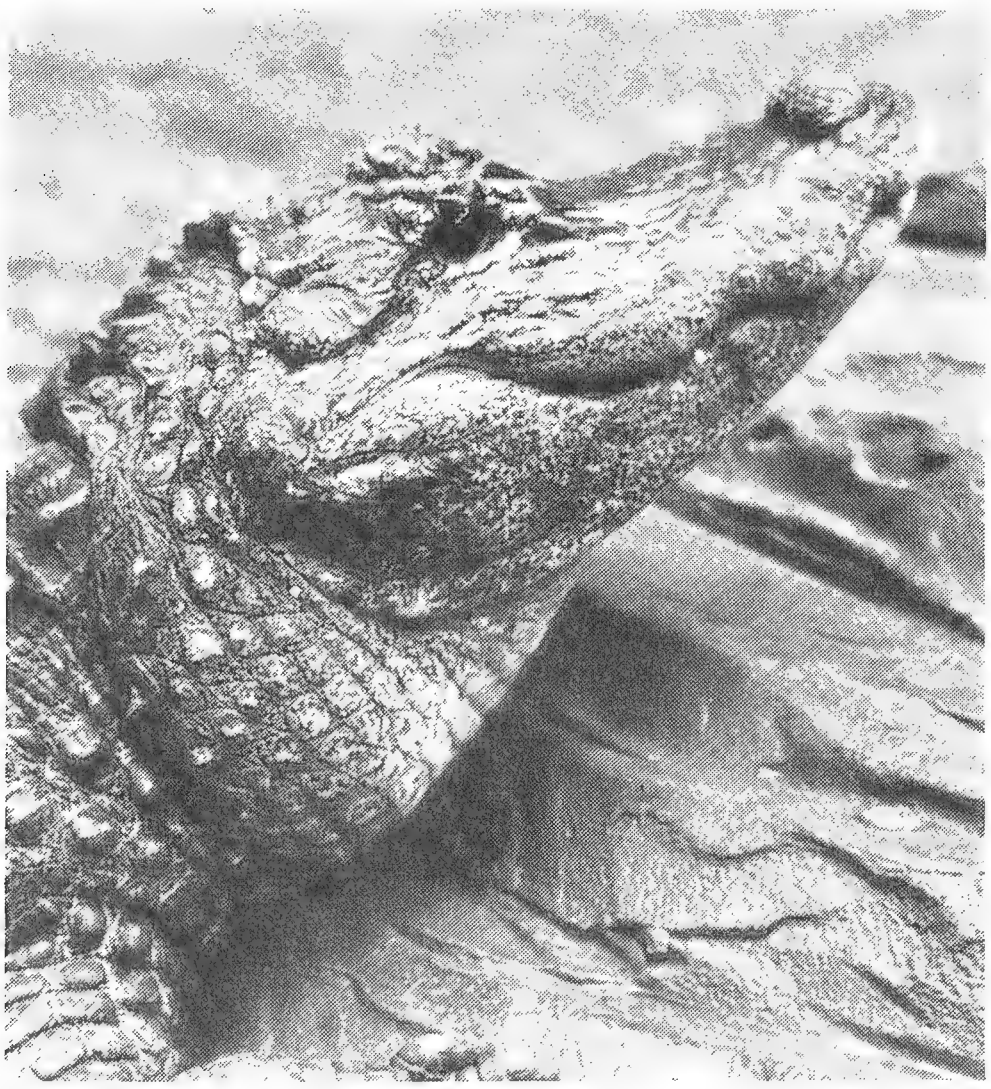


Reptiles and Amphibians



The male of the Zoo's pair of Chinese alligators, at the Reptile House *(number 19 on map).*

Chinese Alligators

The National Zoo's pair of Chinese alligators *(Alligator sinensis)* are among the oldest animals in the collection, having arrived here in 1937; but recently they have shown signs of new liveliness. This past winter, the pair were moved to new quarters – a spacious enclosure on the right hand wall of the Reptile House *(number 19 on map)* similar to those occupied by the Zoo's other full-grown crocodilians – and they soon began behaving in a way that raised hopes of an almost unprecedented breeding of this rare species in captivity. They were observed mating in December, and thereafter several signs seemed to indicate that the mating may have been successful. The female's abdomen appeared swollen, indicating the possibility that she was carrying eggs. Moreover, she began roaring – carrying eggs. Moreover, although she is considerably smaller than the male, she became aggressive towards him and kept him away from her vicinity. She also stopped eating – again normal for a female prior to laying her eggs. While it is too early to tell as yet, keepers continue to watch the female Chinese alligator closely for further signs of impending nest-building and egg-laying.

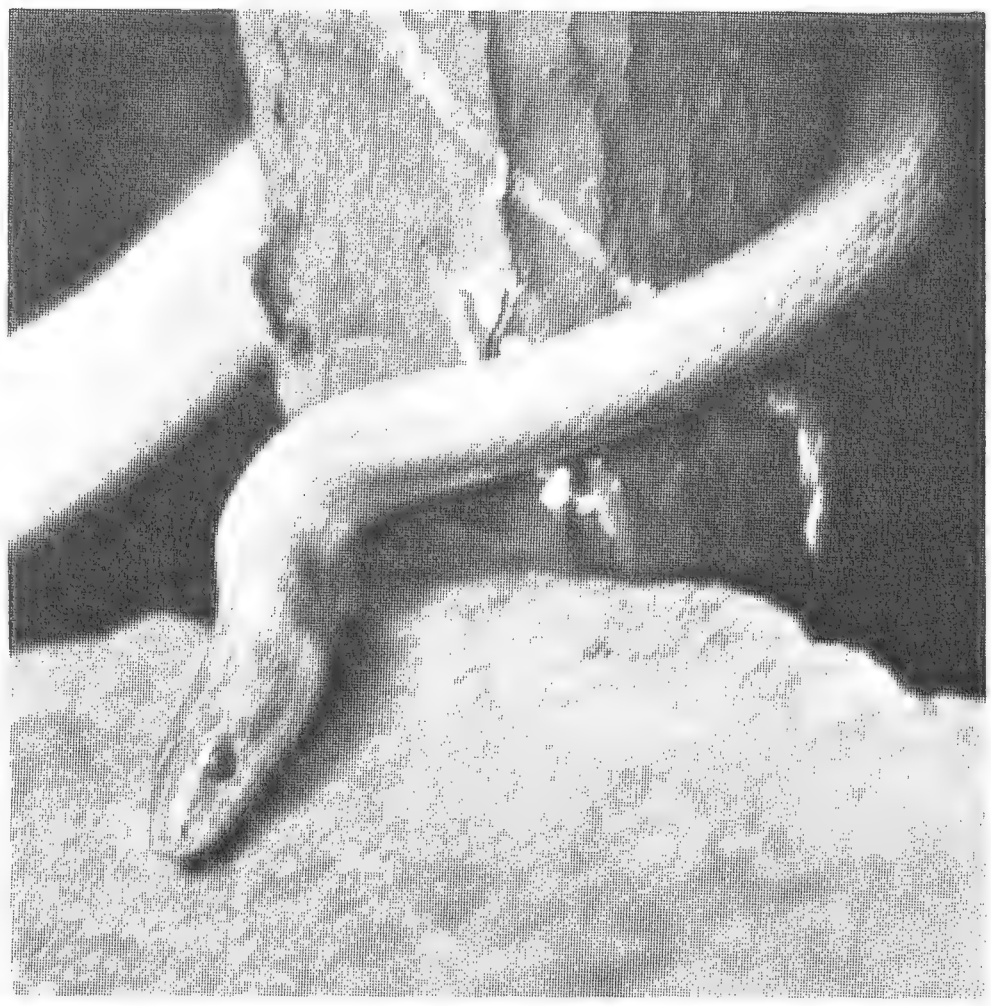
The Chinese alligator is found only in the flood plains of the lower Yangtze valley, although its distribution is presumed to have been much wider in the past. It is a rare species and is seldom exhibited in captivity. Almost nothing is known of its habits in the wild.

Rat Snake Exhibit

Rat snakes are among the most beautifully colored of North American reptiles. A new exhibit at the Reptile House *(number 19 on map)* shows some of the many differently colored forms of this species that are found in the United States. This exhibit contains three races of rat snakes – *Elaphe obselata obselata, Elaphe obselata quadrivittata,* and *Elaphe obsoleta lindhiermeri.* These are colored, respectively, black, yellow, and blotched gray.

This species has often been called the most arboreal of our snakes. Certainly they do spend a large amount of time in trees, seeking such prey as birds, tree frogs, and squirrels. The name "rat snake" derives from the other large constituent of their diet – small rodents such as rats and mice.

A yellow rat snake.



Deer

Deer, known to scientists as the family *Cervidae,* are found throughout four continents — Asia, Europe, North America, and South America — and also appear in the northwest corner of Africa. In addition, they have been widely introduced by man on Australia, New Zealand, and several oceanic islands. Though they range in size from a twenty-pound full-grown South American pudu to an 1,800-pound bull moose, most of the forty living species in this family are unmistakable as deer; the antlers carried by the males of most species are alone sufficient to distinguish them from any other mammals. The National Zoo has an extensive collection of members of this family, consisting of 48 individuals of seven species. There are sizable breeding herds of muntjac *(Muntiacus muntjak),* sika deer *(Cervus nippon),* Eld's deer *(Cervus eldi),* Père David's deer *(Elaphurus davidianus),* and reindeer *(Rangifer tarandus).* There are also three axis deer *(Axis axis)* and one white-tailed deer *(Odocoileus virginianus).*

Muntjac are tiny and quite primitive deer; adults are less than two feet high at the shoulder and weigh between about 35 and 75 pounds. Native to the forests of India, China, and Southeast Asia, they are represented at the National Zoo by a group consisting of one adult male, two breeding females, three young males, and three young females *(number 3c on map).* Six of these animals were born at the Zoo.

Of the more typical deer, the sika deer of Japan, Formosa, and eastern China has been represented in the National Zoo's collection since 1905; 197 of this species have been born here since that time. The current herd consists of one adult male, two adult females, and one yearling of each sex. In addition there are two juvenile males — already bearing short antlers — sharing a mixed exhibit *(number 3j on map)* with two African pygmy goats *(Capra hircus),* a pronghorn *(Antilocapra americana),* and the Zoo's single male white-tailed deer and three axis deer. A close relative of the sika deer, the Southeast Asian Eld's deer or brow-antlered deer, is represented by two adult males, three adult females, one female yearling, and one male fawn born this past January *(number 3i on map).* There are three races of Eld's deer; the Zoo's herd belong to the Burmese race *(Cervus eldi thamin),* also known as the thamin. The other two races have been considered in danger of extinction for some time; now experts fear that the thamin too is in danger of succumbing to uncontrolled hunting and the conversion of its habitat for agriculture and the grazing of domestic animals.

Even more precarious is the survival of Père David's deer; this species, which fossils show was native to northeastern China, has not existed in the wild for hundreds of years. It was preserved only in an Imperial Game Park in Peking; and, when it was exterminated there during the Boxer Rebellion, it was saved only by carefully organized breeding of the few individuals that had found their way to European zoos. Since 1968, births in the National Zoo's herd *(number 3h on map)* have contributed eleven individuals to the worldwide total of approximately 450 Père David's deer.

The final species in the Zoo's deer collection, the reindeer, is distributed in northern woodlands and tundras around the globe. Twenty subspecies have been named; those native to North America are usually known as caribou. The Zoo's population *(number 3d-e on map)* includes individuals of the barren-ground caribou *(Rangifer tarandus arcticus)* and of the Siberian reindeer *(Rangifer tarandus sibiricus),* as well as one cross between these two subspecies and two individuals of unknown race.

Deer are grouped in the order Artiodactyla or even-toed hoofed mammals. Like other members of this order, they support their weight on two hoofed toes, which are descended from the third and fourth of the original five toes that the ancestors of all mammals had. The first digit has been lost, while the second and fifth are vestigial; they form the so-called "dewclaws" or pseudo-claws at the side of a deer's foot, which never touch the ground except when it is very soft. Deer are included in a suborder of the Artiodactyla known as the ruminants, distinguished by the remarkably complex digestive system they have evolved. Like other members of this suborder — which also includes giraffes, pronghorns, antelope, cattle, sheep, and goats — deer lack incisors on the upper jaw. In their place, there is a pad of tough flesh against which the lower incisors press to tear off grasses, leaves, or other plant food. As soon as it is broken off in this way, the food is swallowed without being chewed. Ruminants have a four-chambered stomach, and each mouthful as it is swallowed passes to the first of these chambers, a large storage pouch known as the rumen. When the animal is finished with its grazing or browsing, it withdraws to a safe place and, by contracting the rumen, brings a portion of the food it has gathered back up into its mouth. Then mouthful by mouthful it carefully chews this stored food — or "cud," as it is usually called — with its molars and premolars; when swallowed again, the fully masticated

Eld's deer on brow-antlered deer *(number 3i on map).*

cud bypasses the rumen and is digested by the rest of the stomach. This system of digestion is of obvious value in protecting the ruminant from predators, since the animal is able to gather and store a large quantity of food in a relatively short time and then retire to chew and digest at leisure in a protected place. Another advantage derives from the presence of bacteria living symbiotically in the rumen. These bacteria break down the cellulose in the walls of plant cells — which the ruminant alone lacks the necessary enzymes to digest — and thus liberate the more nutritious cell contents.

Deer use this remarkable digestive apparatus to feed on a considerable variety of kinds of vegetable matter. Most are both grazers and browsers; in other words, they eat both grasses and the leaves and shoots of trees and shrubs, though the percentage of each of these types of food may vary from species to species and from season to season. Some species include more exotic elements in their diets. The reindeer of the arctic tundra, for instance, consume large amounts of lichens and mosses. The adaptability of deers' feeding habits is shown by the ease with which most species adapt to a new diet in captivity. All of the Zoo's deer thrive on alfalfa hay and a commercial food for horses in pellet form. Some species are also given a specially formulated vitamin-B- and selenium-supplemented "sweet feed" at certain times of the year; and all are able to graze on the grass growing in their enclosures, which is replanted periodically, and are occasionally given freshly cut boughs to browse on.

Antlers are, of course, the most obviously unique characteristic of deer. It is true that various other hoofed mammals have also evolved head weapons and adornments; antelope and their relatives have horns with bony cores, rhinoceroses have boneless horns that grow from the hide, and giraffes and okapis have permanent skin-covered bony proturbances on their heads. But all of these structures are permanent, while the antlers of deer are grown and shed each year. The anomalous pronghorn — neither deer nor antelope — annually grows and sheds pronged sheaths of horn that surmount paired permanent bony plugs on its head. The antlers of deer, however, have no horn in their make-up but consist simply of bare bone.

Interestingly, the earliest deer we know of had no antlers. The deer family seems to have made its first appearance approximately 40 million years ago in Asia; and by the Miocene period — from 25 to 10 million years ago — deer had spread throughout Europe and North America. These ancestral deer were quite small compared to the most familiar recent species. As do such primitive present-day species as the muntjac, they had elongated canines on their upper jaws; but they had no antlers — not even such very simple antlers as those worn by the male muntjac. Among modern species, the Chinese water deer *(Hydropotes inermis)* and the musk deer *(Moschus moschiferus)* are also antlerless but have elongated upper canines.

The male muntjac's antlers are straight, short spikes, adorned only by one tiny hooklike branch near the base of each antler. Other species at the Zoo illustrate some of the variety of shapes of multi-branched antlers that occur in other members of the family. The sika deer's antlers represent one of the most familiar types; other members of this genus such as our familiar American elk or wapiti grow antlers with essentially similar structure. In these species, the antler is based on a main, rear beam, which may have a number of forward-directed points or tines growing from it; and a large forward-directed branch known as the brow-tine grows from the base of this beam. Stags grow an increasing number of points as their age increases, although it is incorrect to suppose that they add a new point each year. When the stag becomes old, however, the antlers tend to degenerate and have fewer points than those of a stag in his prime. In the sika deer, the maximum number of points per antler is usually four including the brow-tine, although stags with five or even six points per antler occasionally occur. At this writing, the Zoo's full-grown male sika deer is carrying antlers with three points each. The Eld's deer belongs to the same genus as the sika deer and wapiti, but its antlers differ in one notable particular. The brow-tine is elongated and forms one continuous curve with the rear beam of the antler; this is the source of the alternative common name of this species, brow-antlered deer.

Other genera represented at the Zoo have some still more unusual forms of antlers. The reindeer is the only species of deer in which the females regularly grow antlers, although very rarely females of some other species are found with diminutive antlers. There is a forward beam and a rear beam on each antler in both males and females, and there are points on both beams. The number of points is much greater in males than in females, and the male's antlers are considerably larger. One male of the barren-ground caribou had 52 points on a pair of antlers. Père David's deer also has unique antlers. A front beam grows almost straight up from the forehead, and the other branches

grow backwards from this.

The growth of antlers is a phenomenal process, the exact nature of which is as yet not entirely understood. First, the young male develops a pair of skin-covered protuberances from the frontal bone of the skull known as pedicels or pedicles; these will be the bases on which each year's set of antlers will grow. Experiments have shown that if the pedicles are removed, antlers are never developed; and there is some evidence that the formative tissue of antler originates in the connective tissue of the skin that covers the pedicles. In any event, the antler begins as fibrous tissue below the pedicle skin. More and more of this fibrous tissue develops; and, as it continues to grow, it is gradually turned to bone at its base. Bone-forming calcium is carried from the cavity of the skull to the growing antler by means of an elaborate system of blood vessels. Meanwhile, the blood-rich pedicle skin grows too and provides a covering — called "velvet" — for the developing antler.

When the antler has reached its full size and is fully ossified, the bone at its base becomes increasingly dense, forming a ring known as the coronet or burr just above the pedicle which eventually cuts off the blood supply from the cavity of the skull to the antlers. Subsequently the velvet too loses its blood supply and dies. The dry velvet begins to peel off, a process which the stag frequently helps to accelerate by rubbing his antlers on shrubbery. When the velvet is shed, the stag is said to be "in hard antler."

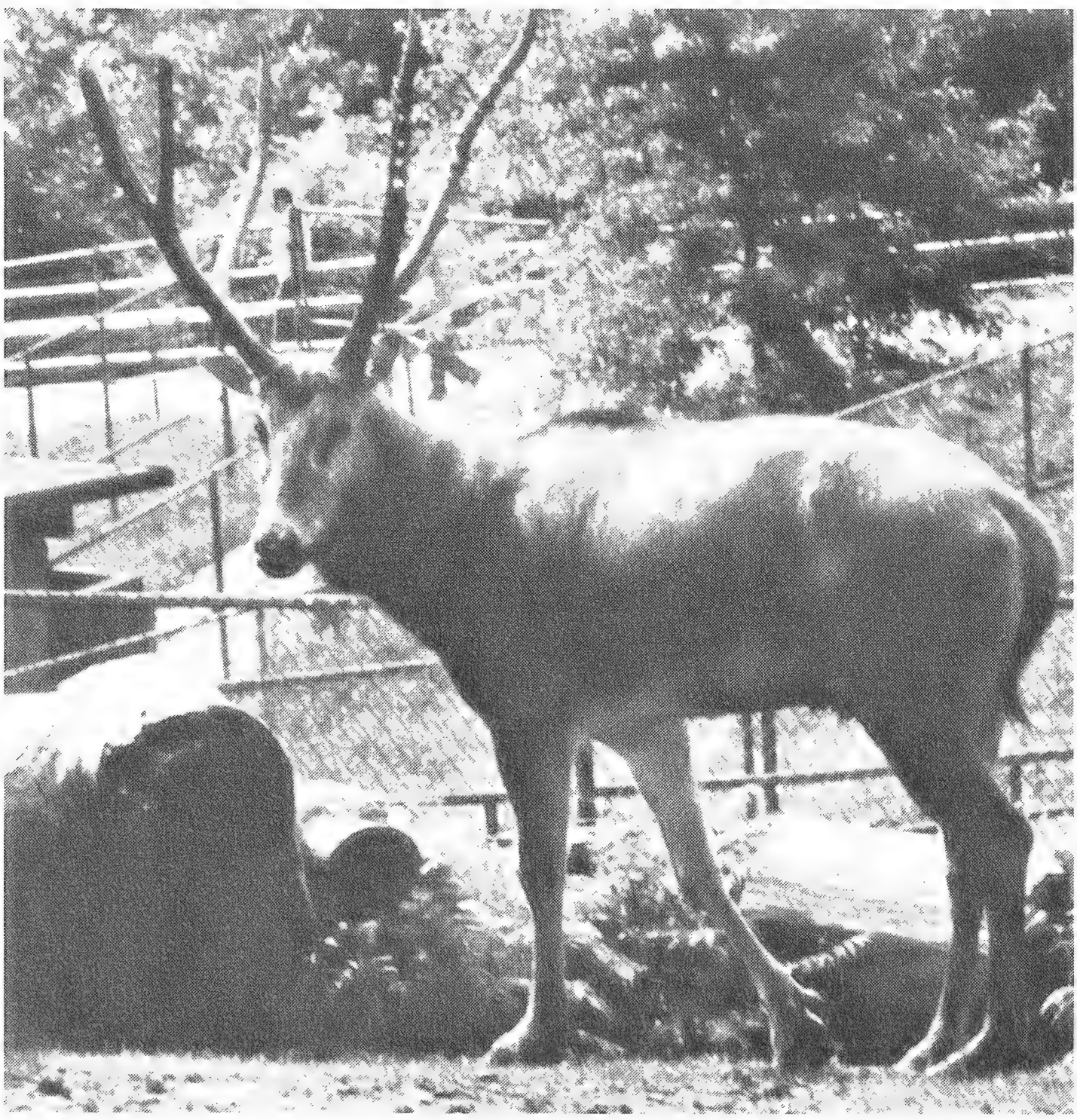
In temperate climates, stags of most species are in velvet during the spring and summer and by the fall mating season or "rut" are in hard antler. The sika deer of Japan, for instance, have finished shedding the velvet

Male reindeer in velvet *(number 3a-b on map).*

about mid-September, and the rutting season lasts from that time till the end of October. Stags of most Temperate Zone species retain their antlers throughout the winter and drop them in the spring, the next year's growth beginning shortly after the previous year's antlers are dropped. In the sika deer, most males drop their antlers in May in the northern hemisphere, although older individuals may do so in April and younger ones in June.

As this sort of schedule suggests, antler growth and the male's annual reproductive cycle are closely connected. Experiments have shown, for instance, that the male hormone testosterone plays an important role in stimulating antler production. Male deer castrated as fawns will not ordinarily grow antlers; however, if such a castrated male — or a spayed female — is given testosterone injections, it will grow small antlers. Moreover, in Temperate Zone species the growth of antlers closely parallels cyclic changes in the testes. The testes are small and inactive in spring when the previous year's antlers are being dropped and new antlers are beginning to grow. As the development of the antlers proceeds, the testes enlarge, and sperm production increases, reaching a peak that coincides with the period of hard antler and the mating season.

The mechanism responsible for the annual growth and shedding of deer antlers is only beginning to be understood; but recent investigations have shown that photoperiod — the amount of light to which the animal is exposed each 24 hours — plays a crucial role. In one study, sika deer stags were kept under artificial light so that the effects of different "day lengths" on their antler production could be ascertained. It was found that new antler growth was usually stimulated by a period of days containing gradually increasing amounts of light per 24 hours that took place subsequent to a period of gradually decreasing amounts of light per 24 hours. This corresponds, of course, to the natural beginning of new antler growth as days begin to lengthen in the spring following the decrease in day length the previous fall. However, the length of the artificially controlled "year" could vary greatly. Sika deer stags could be made to grow as many as four sets of somewhat stunted antlers in one calendar year if subjected to four artificially produced three-month cycles of decreasing and increasing day lengths during that time.



Père David's deer stag *(number 3h on map).*

Female reindeer *(number 3a-b on map)*. This is the only species of deer in which females regularly bear antlers.

Stags also tended to produce only one set of normally sized antlers over a two-year period if subjected to a cycle of day lengths twice as slow as the natural one.

Further study, however, showed that there is no simple cause-and-effect relationship between photoperiod and antler growth. When sika deer were exposed to "days" of constant length for a prolonged period of time, they adjusted their antler growth in interesting ways. When exposed constantly to exactly equal "days" and "nights," stags failed to shed their antlers at all. When exposed to unvarying eight-hour, sixteen-hour, or 24-hour "days," however, they developed an antler cycle equal in length to about 85 percent of the solar year.

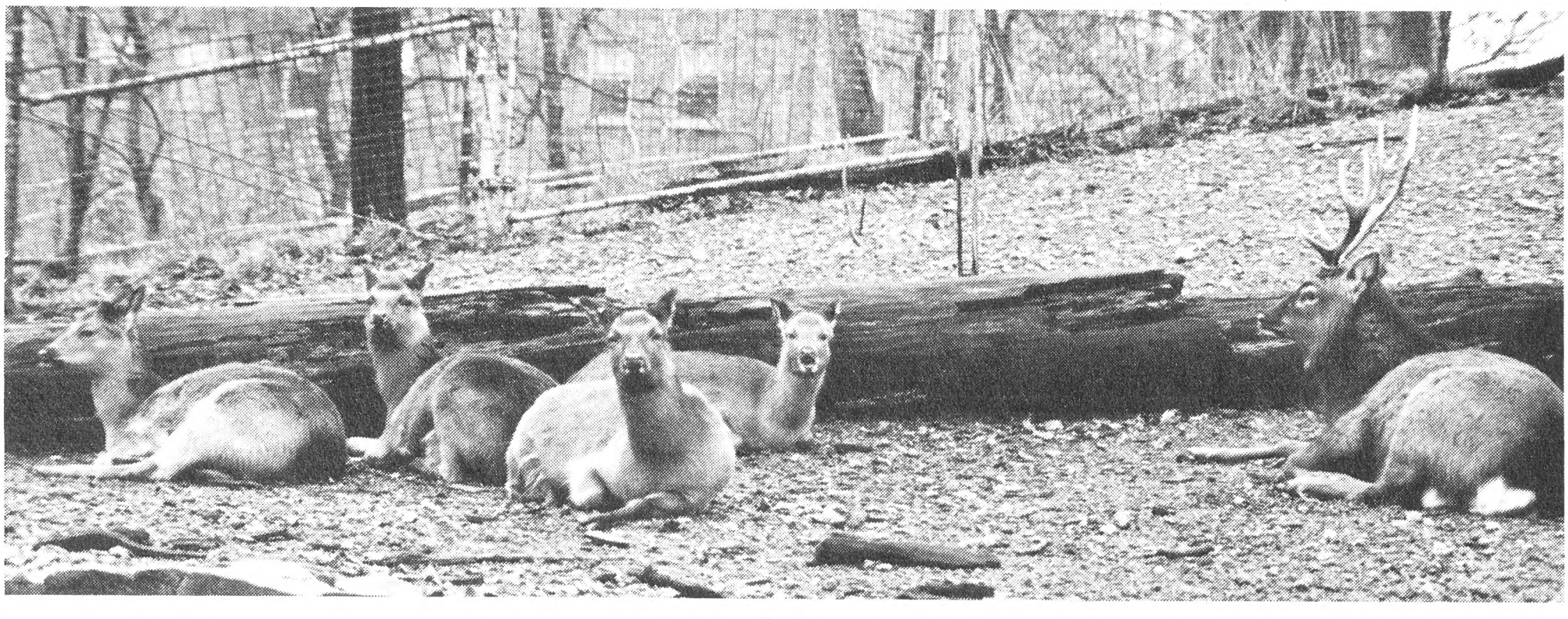
This and other evidence seems to indicate that there is a built-in rhythm on which antler-growth is based and that this rhythm is stimulated and modified to a certain extent by photoperiod. Interestingly, such tropical species as the eld's deer shed their antlers each year, but each stag has a cycle of his own which he does not necessarily share with any other stag. In addition, stags of this species are able to breed throughout the year. Male muntjac, too, produce motile sperm throughout the year; and on Java, some males of this species can be seen in velvet in the spring and some in the fall.

In the sika deer and other Temperate Zone deer, the antlers' most apparent function is in the intensive combats that take place among males at the onset of the rut. Another preparation for these combats can be seen in the dramatic thickening of the musculature of the neck that takes place after the velvet begins to shed. Evidently this increased development of the neck is helpful in supporting the weight of the antlers and in antler-fencing, and in a stag in his prime it must also have a decided psychological effect. These fights are essentially tests of strength and endurance; since a stag is able to lock antlers with an attacking opponent, serious injury to either combatant is relatively rare. As the rut progresses, each mature stag gathers a herd or harem of hinds to breed with; and he will continue to threaten or fight any other stag that approaches his herd too closely.

The annual production of antlers — which in some species may weigh as much as a quarter of the animal's permanent skeleton — obviously must put a severe strain on the stag's system; and it is felt that such a biologically taxing process must have had some very important function to have been of selective value. But several scientists have questioned whether their function in inter-male combats is sufficient to account for the evolution of such elaborate structures. In the red deer *(Cervus elaphus)* about one percent of males are antlerless; and yet these so-called hummel stags appear to be no less able to obtain and breed successfully with herds of females than are antlered stags. Male muntjac, it has also been pointed out, have evolved antlers but use mainly their elongated canines in their combats.

There is some evidence, however, that a major function of antlers, at least in some species, is to be found not in their use as weapons but in the psychological effect they have on other deer of the same species. The growth of antlers is only one of several changes in the appearance of males that accompany the rut in non-tropical species. The thickening of the neck muscles is another, and there are also changes in the pelage that take place at the same time. For instance, stags of the sika deer and other species develop heavy neck manes in the fall. In autumn, rein-

The Zoo's sika deer herd *(number 3g on map).*



deer grow longer white hairs in among the brown summer hair, producing a striking gray color which is particularly impressive on the neck. All these changes in the region of the head and neck — which is the area first seen by another of the same species — cannot fail to have an effect.

Other evidence from the reindeer provides further suggestions of the value antlers can have as social signals. For example, the antler combats that take place between male reindeer at the time of rut have been reported to take place only between males of approximately equal age and, therefore, approximately equally sized antlers. Older males come into rut earlier than younger males, so that older males begin to gather herds of females before younger males. At this time, younger males will defer automatically to an older male and avoid conflict with him. When the younger males come into rut and begin to show aggression towards other males, they tend to fight with males of about their own age which are also just coming into rut at the same time. The size of the antlers quite possibly help such males in recognizing each other.

When a male sees a male of similar age approaching he may avoid fighting but warn the other male away by means of various threatening signals. This is particularly likely to happen after harems have been formed. One such signal involves the antlers, which the male reindeer rubs on a nearby shrub or tree as a warning. Stags of many other species of deer rub their antlers on branches, often stripping them of leaves, apparently as a kind of warning mark.

The reindeer is aberrant, of course, in that the females bear antlers; and the female reindeer's antlers seem even more clearly to play a role as social signals. Interestingly, the adult female's antler-growth cycle does not correspond with that of the adult male. In Scandinavia, male reindeer shed the velvet during August and are in hard antler for a rut that lasts from late August to late October. In early winter, the males begin to drop their antlers, although all do not do so at once. In this respect, they differ from such typical deer as the sika in that they are antlerless in winter. Breeding female reindeer, on the other hand, do keep their antlers until spring; they shed them at calving time in April and soon afterwards begin to grow a new set. In winter reindeer live in mixed herds of males and females. In these herds, the dominance of females increases greatly with respect to the then mainly antlerless males, and evidently the possession of antlers plays a large role in enhancing the females' status.

In the far northern winter, the life of the reindeer is very difficult, and usually the lichen, brush, and grass on which they feed can only be found by digging through the snow. With their front legs the reindeer dig feeding craters in the snow about sixteen inches wide, and usually certain animals regularly defer to others for first access to the craters. Calves born the previous spring follow their mothers and depend on them to find food; and thus the females' relatively high social status at this time has direct value for the survival of their offspring and, thus, for the perpetuation of the species.

The barren-ground caribou of the Canadian north make large-scale annual migrations to traditional calving grounds in the north every spring; pregnant females initiate these mass movements, travelling in herds that number in the thousands, while males follow several days behind them. When they reach the calving grounds, as many as 80 percent of all the year's births may take place during a four or five day period. Other non-tropical deer also regularly give birth in the spring when conditions are optimum for the fawns' survival. Tropical species — in keeping with their lack of a definite mating season — may give birth at any time during the year, although there may be a birth peak of several months when vegetation is at its most luxuriant. On the Indonesian island of Lombok, for instance, where there are well-marked wet and dry seasons, most muntjac births take place during the rainy season.

At the National Zoo, too, the tropical species — the muntjac and Eld's deer — give birth throughout the year. Young of the former species were born this past November and January, and one fawn of the latter species was also born in January, 1973. But for the rest of the Zoo's deer, spring and early summer are the regular time for birth as they are for non-tropical deer in the wild. At this time in 1972, a sika deer, two reindeer, and five Pére David's deer were born; and Zoo visitors should be able to expect a similar number of fawns this year.

Back cover: Sika deer stag *(number 3g on map)*.